Oriental Fruit Fly Studies

mass culture of natural enemies of destructive fly possible after two years of laboratory research

Glenn L. Finney

Accidental introduction of the oriental fruit fly—*Dacus dorsalis* Hendel—to the mainland as it was to the Hawaiian Islands is a distinct threat to California agriculture.

Within two years after the oriental fruit fly was first recorded at Honolulu—in May, 1946—the fly populations were estimated in astronomical figures and were ravaging fruit of the islands.

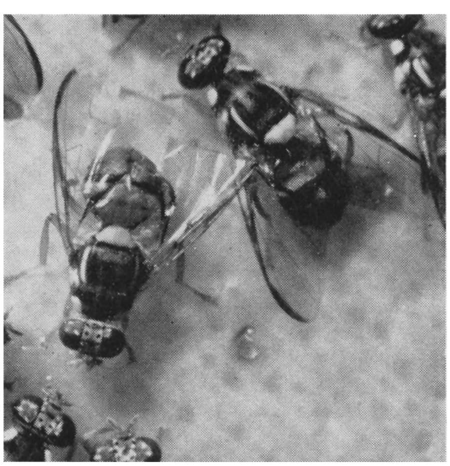
By September, 1949, the University of California's Department of Biological Control had set up a research project—with laboratory facilities in Honolulu—which was to be active over a period of two years.

The knowledge acquired through the investigational studies will assist materially in devising effective strategy for combating the oriental fruit fly should it become established in California.

The primary purposes of the project were to develop efficient methods for mass culture of the most important parasites of the oriental fruit fly; and to study the fly, particularly the nutrition of the larvae and adults, and the role of microorganisms associated with larval growth.

The two parasitic braconid wasps considered most effective were *Opius vandenboschi* Fullaway, which attacks the newly hatched fly larvae, and *Opius oophilus* Full., an egg-larval parasite.

The rearing of the parasites of the fruit fly was contingent upon the discovery of a dependable and efficient method for culturing the fly larvae. Furthermore, it was needful that two fundamental barriers be overcome before any extensive search for a larval medium could be undertaken. These barriers were *1*, the unnaturally long preoviposition period of flies reared in the laboratory, and *2*, the very low egg production of flies held in the insectary when fed yeast, and papaya mash, which was used as a standard diet at that time.



Adult Oriental fruit flies on a fruit surface. Note the conformation and markings. Magnified about four times.

The preoviposition period was reduced to a minimum and large quantities of viable eggs were obtained when new adult fly diets were developed which corrected the deficiencies that existed in the former diet.

An ideal medium for culturing the larvae was finally developed. It consisted of raw carrots, reduced in a blender to a gravy-like consistency, fortified with powdered brewers yeast—to compensate for the intrinsic nutritional deficiencies of the carrots—with hydrochloric acid—to inhibit the development of bacteria—and with Butoben—*n-bytylparahydroxybenzoate*, Merck—to suppress the growth of undesirable molds and exotic yeasts.

As many as 15,000 mature larvae were cultured from 21,000 eggs in a pan-unit containing 2,400 milliliters of medium one inch in depth.

The two species of parasites—the braconid wasps—chosen for laboratory production did not attack loose, free, fly eggs nor would they traverse the wet surface of the culture medium. The parasites would attack the eggs or young larvae only at the site where the eggs were deposited in the natural flesh of a fruit, usually through the skin puncture made by the female fly. Consequently some means had to be found for exposing the fly eggs or young larvae to the parasites before placing them in the carrot medium. It was discovered that apples could be used successfully to support high concentrations of the host material during this period of parasitization.

Two-inch, tangential, unpeeled sections of apple were exposed to the flies until a large concentration of eggs had been deposited. These sections were then placed in parasite cages where the wasps oviposited in the newly laid host eggs or the recently hatched host larvae. The sections containing this parasitized material were then transferred at the proper time to the carrot medium where the larvae developed to maturity. These mature larvae were then removed, and allowed to pupate in cans of sand. A good percentage of the puparia yielded parasites which came out of the sand immediately after the regular emergence of flies from the unparasitized material.

Concurrent Tests

In associated studies of the melon fly—*Dacus cucurbitae* Coquillett—the carrot medium when slightly modified proved to be suitable for the development of the melon fly larvae. The culture method, however, was not as dependable with this species as with that of the oriental fruit fly. The melon fly larvae were reluctant to feed on the medium if it contained Butoben without which the medium became more subject to the growth of molds and undesirable yeasts.

The Mediterranean fruit fly—*Ceratitis capitata* Weidemann—also was cultured in limited quantities using the fortified carrot medium for production of the larvae. Certain techniques such as those used in feeding the adult flies were modified for the rearing of the Mediterranean fruit fly.

The two-year period allowed for this project expired before the culture of parasites could be fully explored but it was demonstrated that it is possible to produce these parasites in quantity under laboratory conditions. It is questionable

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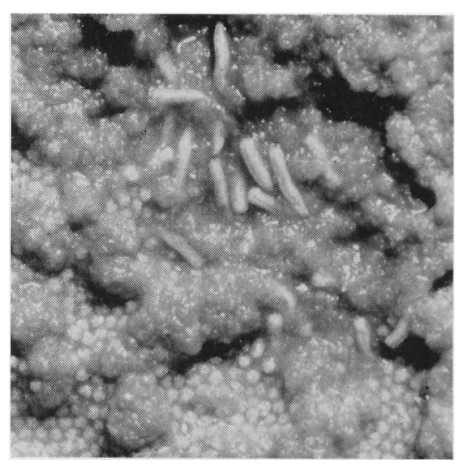

Oriental fruit fly larvae. White spots are larvae feeding perpendicularly in culture-medium. Approximately life size.

Orchard Plow-Pans

obstacle to root distribution and water penetration can be reduced

E. L. Proebsting

Effects of a plow-pan in an orchard—interference with normal distribution of tree roots and with the rate of water penetration into the deeper soil layers—can be counteracted to a considerable degree by a soil management program.

A compacted layer of soil—the plow-pan—usually 6″–12″ thick, lies below the depth of cultivation in many California orchards and is the result of the action of plows or disks.

Plow-pans have developed in many soils prior to the planting of orchards. The orchard comprising the covercrop experimental block on the Davis campus was planted on land that had been in grain most of the preceding 60 or more years. The plow-pan was so well developed that portions of it were taken to Berkeley for class instruction by the Soils Department.

From time to time, since the covercrop experiments were started in the Davis orchard—1924—it was reported that the plow-pan condition had improved. Also it was reported that an improvement in water penetration had been noted in the plots which have been clean cultivated continuously. A study, in the fall of 1952, to determine apparent soil density in the plots in this block detected no significant differences in this property with the possible exception that in the Melilotus indica plot the apparent density seemed less than the others. In the clean cultivated plots, good practice—waiting until a satisfactory moisture content was reached—has corrected the plow-pan condition.

Another study which points in the same direction was made in 1951–1952 to determine root distribution under clean cultivation and under non-cultivation where weed growth had been prevented by sprays.

Results

No roots were found in the surface layer of soil in the cultivated area of a Gaume peach orchard in Sutter County, which would naturally follow their destruction by cultivation. There were very few roots in the 6″–12″ layer, which had not been disturbed. Complete permeation by roots had occurred in the second foot of soil which is a Gridley loam. In contrast, the soil in the area which had not been cultivated for seven years was well supplied with roots below about 2″. Measurement of soil samples from these two plots showed apparent density—in the 6″–12″ layer—of 1.44 in the cultivated plot and 1.28 in the non-cultivated area. Although the greater density in the cultivated plot was not enough to exclude roots, it may have been dense enough to reduce their frequency.

It was noted that after a fall rain of about 4″, penetration was only about 12″ in the cultivated soil whereas it was over 24″ in the non-cultivated soil. Assuming that texture and residual moisture were comparable in the adjacent areas, and that one inch of water would bring five or six inches of soil from the wilting percentage to field capacity, all of the rain penetrated in the non-cultivated plot while about half of it was lost from the tilled surface.

Data were obtained from two almond orchards, both on Yolo loam, in the Capay Valley in Yolo County. Root distribution followed the same pattern as the Gaume peaches in the Sutter County study. There was no surface rooting and few roots were in the 6″–12″ layer in the cultivated area but there were roots throughout the entire soil profile below about 2″ in the non-cultivated plots. Apparent soil densities in one orchard were 1.76 in the cultivated area and 1.56 in the non-cultivated area. In the second orchard they were 1.66 in the cultivated and 1.19 in the non-cultivated areas. The 1.76 figure is in the range considered too dense to permit root growth or water extraction.

An olive orchard sampled in Glenn County on San Joaquin loam showed greater soil variability, but the rooting habit followed the same pattern. The apparent density measurements gave values of 1.60 in the cultivated and 1.43 in the non-cultivated.

Root distribution in a nectarine orchard in Tulare on a Tujunga sandy loam again showed the same contrast as the ones above. This orchard had plots in which the differential treatment had continued for eight years. It seemed to the eye that the trees in the non-cultivated area were the larger, but trunk circumference measurements gave the values: 23.6 ± .48″ for the cultivated and 25.4 ± .59″ for the non-cultivated areas, a difference which is not significant, although in the direction expected.

A Santa Rosa plum orchard in Tulare County on San Joaquin loam did not have a cultivated check for comparison. Roots were well distributed and soil samples were taken from an adjacent cultivated fig orchard for comparison. The apparent densities were 1.66 in the cultivated and 1.53 in the non-cultivated or-

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whether this can be done on a sound economic basis because the present methods require much hand work which increases man-hours to a point where a mass culture program for parasites would be impracticable. For example, the male parasites must be removed from the presence of the females and held isolated for a period of six or seven days before they can successfully mate with newly emerged females.

When the insect rearing laboratory was set up most of the flies used as test insects were obtained from field sources by trapping them in the heavily populated wild guava areas or by rearing them out of heavily infested fruits brought into the laboratory.

The California laboratory developed and amplified the culture of the oriental fruit fly to a point where it was able to supply over five million of this species to the Federal agency alone for test purposes. This species was more desirable for experimental work than the former field flies since they were well standardized, age-dated and had been reared on a common medium.

Anticipating the possible accidental introduction of the oriental fruit fly, the State of California has, through the work done in Hawaii, gained two years against the time of the pest's arrival.

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Harry S. Smith, Professor of Entomology, Emeritus, was Chairman, Biological Control, at the time the study reported here was made.

The above progress report is based on Research Project No. 1411 organized and implemented by Harry S. Smith, Chairman of the Department of Biological Control.

The study of adult fly nutrition was done by Kenneth S. Hagan, Junior Entomologist, University of California, Albany, California. The studies of larval nutrition and associated micro-organisms were done by Shizuko Maeda, United States Department of Agriculture, Hawaii.